MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

DCA5068 – FIELD THEORY

(Diploma in Electronic Engineering)

9 MARCH 2018
3:00 PM – 5:00 PM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **5** pages (4 pages with 4 questions and 1 page for appendix).

2. Answer **ALL** questions. All necessary working steps must be shown.

3. Write all your answers in the answer booklet provided.

QUESTION 1 [25 Marks]

a) Two points are located in a free space. If the coordinates are measured in meter, find the distance from point A ($r = 4.4$, $\phi = -115°$, $z = 2$) to point B ($x = -3.1$, $y = 2.6$, $z = -3$).

[6 marks]

b) In Cartesian coordinate system, vector $\vec{A}$ is directed from point K = (2,7,-5) to point L = (-5,-5,-3) and vector $\vec{B}$ is directed from point M = (0,2,4) to point N = (1,4,5). Find:

i) Vector $\vec{A}$.

[2 marks]

ii) Vector $\vec{B}$.

[2 marks]

iii) $\vec{A} \times \vec{B}$.

[3 marks]

iv) $|\vec{A}|$ and $|\vec{B}|$.

[2 marks]

v) The angle between $\vec{A}$ and $\vec{B}$.

[3 marks]

c) Transform the following vector to cylindrical coordinate system at the specified point:

$$\vec{A} = 2\hat{\imath} + \hat{\jmath} + \hat{k} \text{ at P}(x = 2, y = 3, z = 4)$$

[7 marks]

Continued...

QUESTION 2 [25 Marks]

a) A charge Q_T is located at the origin and acts as a point charge to create an electric field between three other point charges of $Q_1 = 20\ \mu C$, $Q_2 = 30\ \mu C$ and $Q_3 = 10\ \mu C$ which are located at (3,0,5), (-2,0,3) and (2,0,1) respectively. Calculate the electric field strength at Q_T.

[11 marks]

b) By referring to Figure 1 below, calculate the total force, F_T on the point charge placed at the origin (0,0,0).

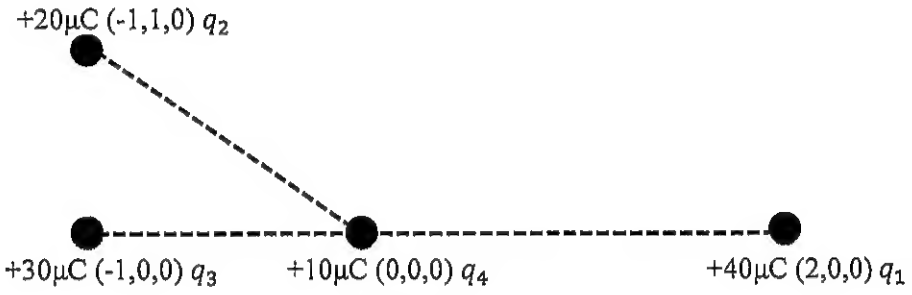

Figure 1

[10 marks]

c) Three capacitors with the value of 10 μF each are being connected in parallel with a 5 V voltage supply. Calculate:

i) The total capacitance, C_T of the circuit.

[2 marks]

ii) The charge stored on each of the capacitor.

[2 marks]

Continued...

QUESTION 3 [25 Marks]

a) A single circular loop in the plane of the paper lies in a 0.90 T magnetic field pointing into the paper. If the loop's radius changes from 50 cm to 20 cm in 0.70 s, find:

i) The direction of the induced current.

[1 mark]

ii) The magnitude of the average induced EMF.

[8 marks]

iii) The average induced current if the coil resistance is 15 Ω.

[2 marks]

b) Calculate the magnitude of the induced EMF in the loop, when 7 Wb/m^2 magnetic fields is directed perpendicular to the plane of a 150 turns loop, which has a diameter of 0.2 m. The loop is rotated through the 145° in 0.30 s.

[6 marks]

c) According to Faraday's law of induction, what are the factors that affect the magnitude of the induced current?

[3 marks]

d) How to calculate a magnetic field across any closed loop path? Justify your answer.

[2 marks]

e) If a bar magnet is being inserted into a coil of wire that conducts electricity, what is the direction of an induced current? Justify your answer.

[3 marks]

Continued...

QUESTION 4 [25 Marks]

a) Define Magnetomotive Force (MMF).

[3 marks]

b) State three differences between magnetic circuit and electric circuit.

[6 marks]

c) Briefly explain about Eddy currents.

[6 marks]

d) A transformer has a 1:10 voltage ratio. Find the current flow in the secondary winding if the current flow in the primary winding is equal to 60 mA.

[3 marks]

e) Given that the power delivered by the secondary winding is $P_{sec} = 10W$. What is the value of the power delivered by the primary winding P_{pri} in an ideal transformer?

[2 marks]

f) In an ideal transformer configuration, prove the following formula:

$$I_{sec} = \left[\frac{1}{n}\right] I_{pri}$$

[5 marks]

End of Page.

FORMULAE

Transformation	Coordinate Variables	Unit Vectors	Vector Components
Cartesian to Cylindrical	$r = \sqrt{x^2 + y^2}$ $\phi = \tan^{-1}(y/x)$ $z = z$	$\hat{r} = \hat{x}\cos\phi + \hat{y}\sin\phi$ $\hat{\phi} = -\hat{x}\sin\phi + \hat{y}\cos\phi$ $\hat{z} = \hat{z}$	$A_r = A_x\cos\phi + A_y\sin\phi$ $A_\phi = -A_x\sin\phi + A_y\cos\phi$ $A_z = A_z$
Cylindrical to Cartesian	$x = r\cos\phi$ $y = r\sin\phi$ $z = z$	$\hat{x} = \hat{r}\cos\phi - \hat{\phi}\sin\phi$ $\hat{y} = \hat{r}\sin\phi + \hat{\phi}\cos\phi$ $\hat{z} = \hat{z}$	$A_x = A_r\cos\phi - A_\phi\sin\phi$ $A_y = A_r\sin\phi + A_\phi\cos\phi$ $A_z = A_z$
Cartesian to Spherical	$R = \sqrt{x^2 + y^2 + z^2}$ $\theta = \tan^{-1}(\sqrt{x^2 + y^2}/z)$ $\phi = \tan^{-1}(y/x)$	$\hat{R} = \hat{x}\sin\theta\cos\phi + \hat{y}\sin\theta\sin\phi + \hat{z}\cos\theta$ $\hat{\theta} = \hat{x}\cos\theta\cos\phi + \hat{y}\cos\theta\sin\phi - \hat{z}\sin\theta$ $\hat{\phi} = -\hat{x}\sin\phi + \hat{y}\cos\phi$	$A_R = A_x\sin\theta\cos\phi + A_y\sin\theta\sin\phi + A_z\cos\theta$ $A_\theta = A_x\cos\theta\cos\phi + A_y\cos\theta\sin\phi - A_z\sin\theta$ $A_\phi = -A_x\sin\phi + A_y\cos\phi$
Spherical to Cartesian	$x = R\sin\theta\cos\phi$ $y = R\sin\theta\sin\phi$ $z = R\cos\theta$	$\hat{x} = \hat{R}\sin\theta\cos\phi + \hat{\theta}\cos\theta\cos\phi - \hat{\phi}\sin\phi$ $\hat{y} = \hat{R}\sin\theta\sin\phi + \hat{\theta}\cos\theta\sin\phi + \hat{\phi}\cos\phi$ $\hat{z} = \hat{R}\cos\theta - \hat{\theta}\sin\theta$	$A_x = A_R\sin\theta\cos\phi + A_\theta\cos\theta\cos\phi - A_\phi\sin\phi$ $A_y = A_R\sin\theta\sin\phi + A_\theta\cos\theta\sin\phi + A_\phi\cos\phi$ $A_z = A_R\cos\theta - A_\theta\sin\theta$
Cylindrical to Spherical	$R = \sqrt{r^2 + z^2}$ $\theta = \tan^{-1}(r/z)$ $\phi = \phi$	$\hat{R} = \hat{r}\sin\theta + \hat{z}\cos\theta$ $\hat{\theta} = \hat{r}\cos\theta - \hat{z}\sin\theta$ $\hat{\phi} = \hat{\phi}$	$A_R = A_r\sin\theta + A_z\cos\theta$ $A_\theta = A_r\cos\theta - A_z\sin\theta$ $A_\phi = A_\phi$
Spherical to Cylindrical	$r = R\sin\theta$ $\phi = \phi$ $z = R\cos\theta$	$\hat{r} = \hat{R}\sin\theta + \hat{\theta}\cos\theta$ $\hat{\phi} = \hat{\phi}$ $\hat{z} = \hat{R}\cos\theta - \hat{\theta}\sin\theta$	$A_r = A_R\sin\theta + A_\theta\cos\theta$ $A_\phi = A_\phi$ $A_z = A_R\cos\theta - A_\theta\sin\theta$

Permittivity of free space, $\varepsilon_o = 8.854 \times 10^{-12}\ F/m$

Permeability of free space, $\mu_o = 4\pi \times 10^{-7}\ T.m/A$